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FULL LENGTH ARTICLE

Reproductive biology of Catfish *Chrysichthys auratus*, Geoffroy Saint-Hilaire, 1809, (Family: Bagridae) from Damietta branch of the River Nile, Egypt

Evelyn Ragheb

National Institute of Oceanography and Fisheries, Alexandria, Egypt

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Abstract Reproductive biology of 803 specimens of *Chrysichthys auratus* from Damietta branch of the River Nile, Egypt was studied between January and December 2010. The overall sex ratio (M:F = 1:1.18) was significant at $P < 0.05$ and the ratio showed insignificant variation in summer and autumn. The length of the onset sexual maturity was 12.3 cm SL at age 1.34 years for males and 9.7 cm SL at age 0.56 years for females. *C. auratus* showed prolonged spawning season extending from October to June with a peak in March for both sexes and the fish restart their reproductive cycle in July. The maximum value for GSI and GI were shown in March for both sexes (GSI = 0.49% ± 0.30 and 11.17% ± 9.65 for males and females respectively and GI = 1.02% ± 0.64 for males and 22.85% ± 20.00 for females). The reproductive load was 0.464 and 0.366 for males and females respectively. The study of ova diameters showed protracted and indefinite spawning period with diameters ranging from 0.3 to 3.0 mm (mean value = 1.53 ± 0.45). The absolute fecundity ranged from 696 to 4687 eggs but the relative fecundity was from 70 to 247 eggs/unit fish length. The results showed that *C. auratus* has different life history strategies in Egyptian River Nile water than any other African Rivers.

Introduction

The long fin Catfish, *Chrysichthys auratus* is an African species, which belongs to Siluriformes (Family: Bagridae). It is abundant in the River Nile of Egypt (Damietta branch) and is commercially important.

Determining the reproductive pattern is essential to manage and improve the fishery biology of any species, as it is a key link in the life history of the fish. Generally, the pattern of reproduction characterizes their strategies and the reproductive tactics trait that varies within this pattern and evoke in response to environmental fluctuations (Gomiero et al., 2008).

Few documented studies on reproductive biology of *C. auratus* were given by Sturm (1984) in Tiga Lake in Northern Nigeria; Laleye and Philippart (1993) in Lake Nokoue and Porto-Novo Lagoon (Benin); Bishai and Khalil (1997) in the

E-mail address: Evelynragheb@yahoo.com
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Egyptian sector of the Nile; Ikomi and Odum (1998) in River Benin, Niger Delta, Nigeria; Inyang and Ezenwaji (2004) in a natural west African lake and Atobatele and Ugwumba (2011) from Aiba reservoir, Nigeria. Nevertheless, no studies had been done on the reproductive biology of *C. auratus* in the River Nile at Damietta branch of Egypt.

Ragheb (2014) provided information on the fishery biology of this species, mentioned the distribution of the fish in the African Rivers, and tried to complete the vision by studying reproductive biology of this species.

So, the aim of this study was to throw light on the reproductive biology of *C. auratus* in the River Nile by studying sex ratio, size and age at first sexual maturity and reproductive cycle through monthly distribution of maturity stages, gonadosomatic index (GSI), gonad index (GI), egg diameter (ED) and fecundity which are examples of variable traits in the reproductive strategy of the species.

Material and methods

A total of 803 fish of *C. auratus* were monthly collected from catch landings obtained by fishermen using gill net in water of Damietta branch (River Nile, Egypt) from January to December 2010.

For every fish the standard length (cm), body weight (g) and gonad weight (0.01 g) were recorded. The sex of each fish was also determined. The ovaries of ripe females were preserved in 10% formalin solution. Maturity stages were determined according to Nikolsky (1963) with some modifications into six maturity stages: immature (stage I), maturing (stage II), nearly ripe (stage III), ripe (stage IV), spawning (stage V) and spent (stage VI).

The reproduction potential was estimated from the study of sex ratio (number of males:number of females). The length at first sexual maturity for males and females were estimated from the length at which 50% of fish were mature during spawning season. The corresponding age was determined from von Bertalanffy model which was given by Ragheb (2014).

The gonadosomatic index (GSI) was computed according to the following formula: G.S.I = Gonad weight/Gutted body weight * 100 (Yuen, 1955). The gonad index (GI) was calculated by the following formula: $GI = Gw/L^3 * 10^k$ (Kikawa, 1953) where Gw = Gonad weight; L = Standard length of the fish; k = factor, which is chosen according to the units adopted for Gw and L and in the present study is k = 4.

The ratio of L_m to L_∞ called 'reproductive load' (Cushing, 1981) was also calculated.

Ova diameters were measured using an eye piece micrometer at 32× magnification and all measurements were then converted to millimeters. The relationship between the ova diameter and the length was studied and the relationship between the gonad index and the ova diameter was also reported.

The absolute fecundity, which involves the actual number of eggs in the ovaries, was estimated as the number of mature ova that is likely to be spawned using ripe ovaries of higher gonadosomatic index and relative fecundity, which means the number of eggs per unit length or weight of fish, was also calculated.

The relationship between the total fish length (L) and the fecundity of either absolute ($F_{Abs.}$) or the relative fecundity ($F_{Rel.}$) can be described by a formula $F = aL^b$ where F is the fecundity, L is the body length (cm), and "a" and "b" are constants whose values are determined using the least squares method.

The relationship between the absolute fecundity and the corresponding gutted body weight is expressed by a linear regression equation of the form F = a + bW, where F and W represent the fecundity and the gutted body weight of fish in grams respectively and "a" is constant and "b" is the regression coefficient.

The data were computed and statistically analyzed using Microsoft Excel 2010.

Results and discussion

Sex ratio

Sex ratio is an important trait in estimating the reproductive biomass and the total population fecundity and it is one of the factors determining the reproductive potential of a population (Marshall et al., 2006).

In the present study, the reproduction potential of *C. auratus* is estimated from study of sex ratio (number of males:number of females). Females are slightly more numerous than males and a sex ratio of 1:1.18 between males and females is obtained. Chi-square test was significant ($X^2 = 5.26$; df = 1; $P < 0.05$).

The length of 369 individuals of the males ranging from 8 to 19 cm SL, made up 45.95%. The length of 434 individuals of the females ranging from 7 to 20 cm SL represented about 54.05%. Females were predominant in all lengths except at length 8 cm SL was parity while males outnumbered females at 9 cm and 11 cm SL (Fig. 1). These differences were not significant using the Chi-square test (At 9 cm SL: $X^2 = 0.040$; df = 1; $P > 0.05$; at 11 cm SL $X^2 = 0.004$; df = 1; $P > 0.05$).

Males only outnumbered females in summer. However, the statistical analysis of Chi-square test showed insignificant differences in summer and autumn, whereas significant differences in winter and highly significant differences in spring (Table 1). Such seasonal variation of sex ratio may be attributed to the pre-spawning migration of males. In the present study, it was observed that the fish submerged themselves between vegetation and rocky areas to avoid fishermen, carried out incubation, protected offspring and avoided energy loss during the cold-water months from December to April and even to early May.

On the other hand, Atobatele and Ugwumba (2011) in their study of sex ratio of *C. auratus* in Aiba Reservoir Iwo, Nigeria showed that the overall male to female ratio was that of 1:0.38 of *C. auratus* and this result was in disagreement with the present study but they also showed that *C. auratus* has a maximum SL of 19.8 cm and mean SL of 14.7 ± 0.5 cm. Bishai and Khalil (1997) and Ragheb (2014) mentioned that the longest fish caught were 20 cm SL in the Nile of Egypt and this is in agreement with the present study.

It is important to stand out the fact that the imbalance in the sex ratio, particularly in adults, is relatively common in fish and have been related to differentiation in growth rate between sexes, mortality and/or the energy costs of reproduction (Potts and Wootton, 1984; Marshall et al., 1998; Vicentini and Araújo, 2003 and Mahmood et al., 2011).

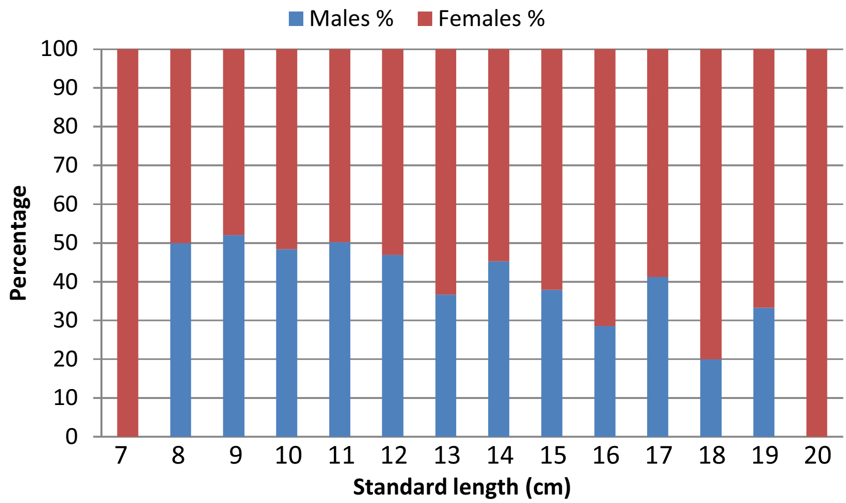


Figure 1 Percentage variations of males and females of *Chrysichthys auratus* per lengths from Damietta branch of the River Nile, Egypt (January 2010–December 2010).

Table 1 Seasonal variations in sex ratio (Males:Females) of *Chrysichthys auratus* from Damietta branch of the River Nile, Egypt (January 2010–December 2010).

Season	Sex ratio					Chi-square value
	Males		Females		M:F	
	No.	%	No.	%		
Winter	29	36.71	50	63.29	1.00:1.72	5.58*
Spring	58	38.93	91	61.07	1.00:1.57	7.31**
Summer	169	52.65	152	47.35	1.00:0.90	0.90
Autumn	113	44.49	141	55.51	1.00:1.25	3.09
Total	369	45.95	434	54.05	1.00:1.18	5.26*

* Significant at 0.05.
** Significant at 0.01.

Length and age at first sexual maturity

The optimal first reproduction size may be needed to maintain the suitable spawning stock and to ensure at least one spawning for the mature. It depends on many factors, including the relative allocation of energy between the gonadal and the somatic growth (Mazzoni et al., 2005) and has been known to be associated with physiological and behavioral changes (Karna and Panda, 2011).

For *C. auratus*, males and females attained their first sexual maturity at lengths of 12.3 cm and 9.7 cm in SL, respectively (Fig. 2), when males were one- year- old (1.34 years) and females had not reached the first year of life (0.56 years). Generally, females reach sexual maturation at smaller sizes than those of males.

Sturm (1984) recorded the females of *C. auratus* attained their first maturity at age group II, in Tiga Lake in northern Nigeria whereas first maturation was recorded at 8 cm TL and 13 cm (100%) in Lake Nokoue and Porto-Novo Lagoon complex in south Benin (Laleye and Philippart, 1993). The disagreement between the present study and the previous studies have been shown to be regulated by environmental conditions where the early reproduction may be related to an adaptive behavior to offset the stochastic mortality imposed by unstable hydrological systems (Mazzoni and Petito, 1999) or in relation to fishing pressure (Lévêque, 1997).

Monthly distribution of maturity stages

As shown in Table 2, *C. auratus* had prolonged spawning season. The males disappeared from the catch in January and the number of this species was low in the catch of winter and early spring from December and even to early May.

It is clear that the period of spawning started in October (3.45% and 4.55% for males and females, respectively) and extended to June with a peak in March (100% for males and 88.24% for females) for both sexes and the fish restarted their reproductive cycle in July.

The spawning period of *C. auratus* at different regions are reported in Table 3. From a structural point of view, it is clear that *C. auratus* have different strategies in the water of the Nile than any other African Rivers and this may be related to major ecological parameters as temperature and photoperiod (Conver and Kynard, 1981; Wootton, 1990 and Patzner et al., 1991). The difference in spawning season between Bishai and Khalil (1997) in the Nile and the present study may be attributed to many factors as the catchment area, number of studied samples and the time of collection.

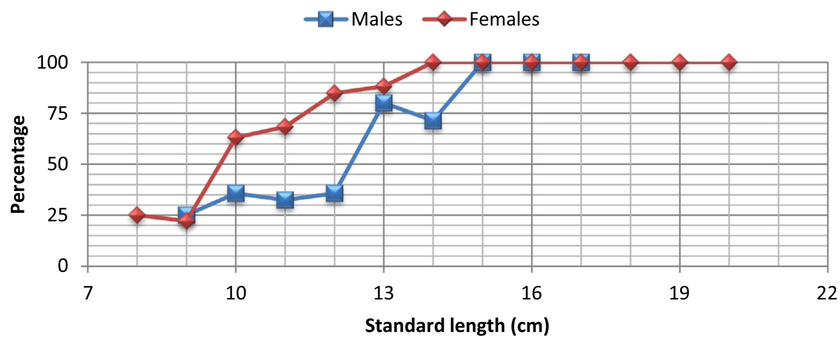


Figure 2 Percentage distribution of mature males and females of *Chrysichthys auratus* per length from Damietta branch of the River Nile, Egypt (January 2010–December 2010).

Table 2 Monthly variations of maturity stages of *Chrysichthys auratus* from Damietta branch of the River Nile, Egypt (January 2010–December 2010).

Month	No. of fish	Male											
		Immature		Maturing		Nearly ripe		Ripe		Spawning		Spent	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
January													
February	10			3	30.00	1	10.00			1	10.00	5	50.00
March	15									15	100.00		
April	9	3	33.33							4	44.44	2	22.22
May	34	22	64.71							4	11.76	8	23.53
June	42	29	69.05	7	16.67					5	11.90	1	2.38
July	77	32	41.56	31	40.26	14	18.18						
August	50	11	22.00	23	46.00	11	22.00	5	10.00				
September	46	14	30.43	15	32.61	14	30.43	3	6.52				
October	29	11	37.93	7	24.14	6	20.69	4	13.79	1	3.45		
November	38	6	15.79	2	5.26	6	15.79	7	18.42	16	42.11	1	2.63
December	19	8	42.11	2	10.53			1	5.26	4	21.05	4	21.05
Month	No. of fish	Female											
		Immature		Maturing		Nearly ripe		Ripe		Spawning		Spent	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
January	4					1	25.00			3	75.00		
February	14			1	7.14	2	14.29	5	35.71	5	35.71	1	7.14
March	17							2	11.76	15	88.24		
April	23	3	13.04							17	73.91	3	13.04
May	51	15	29.41							23	45.10	13	25.49
June	39	12	30.77	9	23.08	5	12.82			5	12.82	8	20.51
July	59	16	27.12	24	40.68	19	32.20						
August	54	15	27.78	18	33.33	16	29.63	5	9.26				
September	58	20	34.48	5	8.62	25	43.10	8	13.79				
October	44	19	43.18	6	13.64	10	22.73	7	15.91	2	4.55		
November	39	7	17.95	1	2.56	3	7.69	13	33.33	14	35.90	1	2.56
December	32	2	6.25	1	3.13	1	3.13	7	21.88	17	53.13	4	12.50

Table 3 Spawning season and the fecundity range of *Chrysichthys auratus* in different geographical areas.

Source	Region	Spawning season	Fecundity
Sturm (1984)	Tiga Lake in Northern Nigeria	April–September	327–1466
Laleye and Philippart (1993)	Lake Nokoue and Porto-Novo Lagoon in South Benin, Nigeria	July–September	–
Bishai and Khalil (1997)	Egyptian sector of the Nile	September–April	–
Ikomi and Odum (1998)	River Benin, Niger Delta, Nigeria	May–July	260–620
Inyang and Ezenwaji (2004)	Natural West African Lake	April–September	625–2184
Present study	Damietta branch of the Nile, Egypt	October–June	696–4687

One of the mostly important observations in the present study is the hypertrophied cheek muscles in reproductive males and females and the darker color for all fish body and this observation is in agreement with some results of Hardman and Stiassny (2008) for the sexually dimorphic species, *Chrysichthys praecox*, in Lac Mai-Ndombe, Congo.

Maturity coefficient

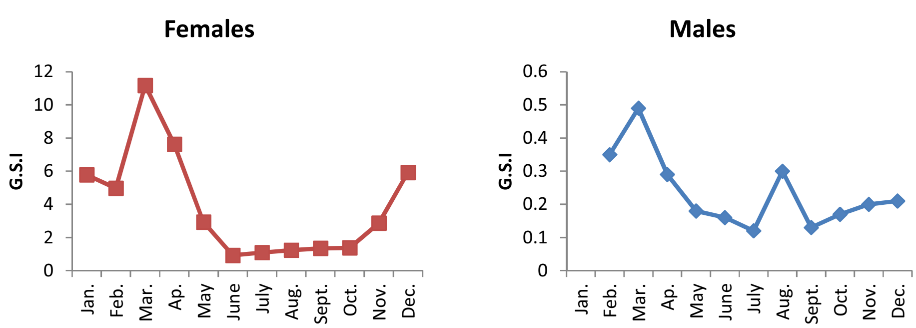
The maturity coefficient or the maturing index is widely accepted as a measure of the sexual activity in fish through studying the gonadosomatic index and/or gonad index.

i. Monthly variations of Gonadosomatic index (GSI) and Gonad index (GI)

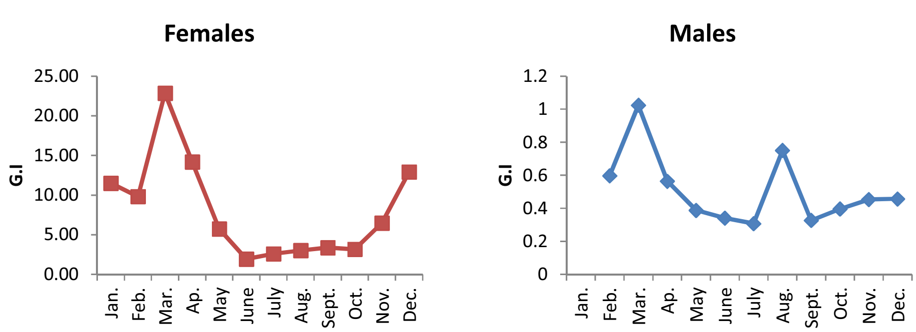
From Table 4 and Fig. 3, it is clear that the GSI of females was much higher extending for a wider range than that of males while the variation in GSI of both sexes followed nearly the same trend. The GSI of both sexes began to increase from October (0.17% ± 0.10 for ♂ and 1.38% ± 1.89 for ♀) reaching its highest value in February (0.35% ± 0.26) and March (0.49% ± 0.30) for males and March (11.17% ± 9.65) and April (7.62% ± 6.62) for females, therefore it is markedly declined in June (0.16% ± 0.18 for ♂ and 0.92% ± 1.17 for ♀). The period from

Table 4 Monthly variations of mean values of gonadosomatic index and gonad index of *Chrysichthys auratus* from Damietta branch of the River Nile, Egypt (January 2010–December 2010).

Month	GSI		GI	
	Male GSI ± SD	Female GSI ± SD	Male GI ± SD	Female GI ± SD
January	–	5.78 ± 3.92	–	11.48 ± 7.81
February	0.35 ± 0.26	4.97 ± 4.11	0.60 ± 0.42	9.82 ± 8.39
March	0.49 ± 0.30	11.17 ± 9.65	1.02 ± 0.64	22.85 ± 20.00
April	0.29 ± 0.15	7.62 ± 6.62	0.56 ± 0.27	14.19 ± 11.89
May	0.18 ± 0.15	2.93 ± 3.57	0.39 ± 0.28	5.74 ± 7.12
June	0.16 ± 0.18	0.92 ± 1.17	0.34 ± 0.37	1.93 ± 2.35
July	0.12 ± 0.06	1.09 ± 1.48	0.31 ± 0.14	2.58 ± 3.54
August	0.30 ± 0.42	1.23 ± 1.84	0.75 ± 1.06	3.01 ± 4.32
September	0.13 ± 0.06	1.35 ± 1.93	0.33 ± 0.17	3.38 ± 4.89
October	0.17 ± 0.10	1.38 ± 1.89	0.40 ± 0.26	3.16 ± 4.50
November	0.20 ± 0.10	2.86 ± 2.90	0.45 ± 0.24	6.47 ± 6.45
December	0.21 ± 0.10	5.92 ± 5.13	0.46 ± 0.22	12.92 ± 11.05



a) Gonadosomatic index (G.S.I)



b) Gonad index (G.I)

Figure 3 Monthly variation of (a) gonadosomatic index and (b) gonad index for females and males of *Chrysichthys auratus* from Damietta branch of the River Nile, Egypt (January 2010–December 2010).

July to September is characterized by the lowest values of GSI and represents the period of resting stages. Therefore, the spawning season of *C. auratus* extends from October to June. Concerning the GI, the trend was much similar to the trend of GSI where the GI of females was much higher extending for a wider range than that of males and the variation in GI of both sexes with months also followed nearly the same trend reaching the highest value in March for both sexes (1.02% ± 0.64 for ♂ and 22.85% ± 20.00 for ♀).

ii. Variations with length of gonadosomatic index (GSI) and gonad index (GI)

The value of GSI showed an increase with the length for both sexes (Table 5). For males the GSI began to increase from 0.21% to 0.53% at lengths 13 cm SL and 18 cm SL, respectively. For females the GSI increased from 0.60% at 9 cm SL to 21.69% at 19 cm SL.

Concerning to GI, the trend was much similar to the trend of GSI where the GI for males began to increase from 0.47% to 1.34% at lengths 13 cm SL and 18 cm SL, respectively and GI of females increased from 1.30% at 9 cm SL to 48.86% at 19 cm SL. The GI of females was much higher extending for a wider range than that of males and the variation in GI of both sexes with the length also followed nearly the same trend of GSI.

It is clear that the GSI and GI showed increasing trend for lengths at the first sexual maturity for both sexes.

Reproductive load

The reproductive loads (L_m/L_∞) of males and females of *C. auratus* in area of investigation were 0.464 and 0.366, respectively where L_∞ was previously computed as 26.53 cm (Ragheb, 2014) and this ratio generally falls between 0.4 and 0.9 and appears to be relatively constant within taxa comprised of fish of approximately similar dimensions (Pauly, 1984).

Ova diameter

The percentage data on egg diameters would throw light on the nature of spawning season. The egg size ranged from 0.3 to 3.0 mm with a mean of 1.53 ± 0.45. Three modes of ova can be detected from size distribution of ova (Fig. 4), the primary mode of immature oocytes (0.3–1.0 mm), the most advanced mode of mature oocyte (1.1–1.8 mm) and the latter mode of ripe completely transparent ova (1.9–3.0 mm) ready for ovulation. Also, the withdrawal of mature ova from the egg stock to undergo maturation is a continuous process and eggs are shed in batches during the spawning seasons. This indicates that the spawning period of *C. auratus* is protracted and indefinite.

The distribution of the mean ova diameters ±SD showed variability among the length group (Table 6) and this variation was insignificantly correlated with SL and the value of $b = 0.1048$ which is significantly different from "1" showed that the relation doesn't relate linearly with length.

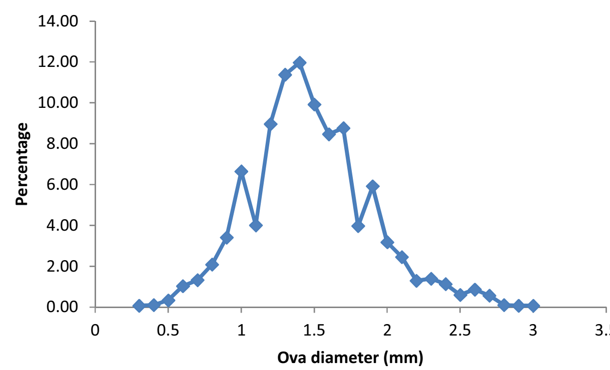


Figure 4 Frequency distribution of ova diameters of *Chrysichthys auratus* from Damietta branch of the River Nile, Egypt (January 2010–December 2010).

Table 5 Variations of mean values of gonadosomatic index and gonad index per length group of *Chrysichthys auratus* from Damietta branch of the River Nile, Egypt (January 2010–December 2010).

Length	GSI		GI	
	Male GSI ± SD	Female GSI ± SD	Male GI ± SD	Female GI ± SD
7	–	0.38	–	0.63
8	0.22 ± 0.14	0.34 ± 0.19	0.45 ± 0.27	0.67 ± 0.42
9	0.21 ± 0.11	0.60 ± 0.70	0.45 ± 0.21	1.30 ± 1.45
10	0.15 ± 0.13	1.80 ± 2.57	0.35 ± 0.23	4.10 ± 5.67
11	0.15 ± 0.12	1.66 ± 2.90	0.35 ± 0.25	3.54 ± 5.90
12	0.15 ± 0.10	2.06 ± 2.47	0.34 ± 0.21	4.43 ± 5.10
13	0.21 ± 0.17	3.84 ± 5.51	0.47 ± 0.37	7.52 ± 10.11
14	0.27 ± 0.27	3.91 ± 3.62	0.66 ± 0.70	7.95 ± 7.09
15	0.39 ± 0.24	5.87 ± 4.41	0.82 ± 0.36	13.53 ± 10.83
16	0.47 ± 0.30	7.22 ± 4.68	0.86 ± 0.53	14.88 ± 8.63
17	0.46 ± 0.38	8.29 ± 9.64	1.14 ± 0.97	17.18 ± 17.80
18	0.53	9.60 ± 8.22	1.34	21.90 ± 17.44
19	0.27	21.69 ± 16.43	0.69	48.86 ± 36.05
20	–	0.77 ± 0.10	–	1.53 ± 0.20

Table 6 Relation between mean ova diameters, gonad index (GI), fecundity and standard fish length for ripe females of *Chrysichthys auratus* from Damietta branch of the River Nile, Egypt (January 2010–December 2010).

Length	No. of fish	Ova diameter (mm)		GI	Absolute fecundity		Relative fecundity	
		No. of ova	Mean ± SD	Mean ± SD	Obs.	Cal.	Obs.	Cal.
10	5	497	1.24 ± 0.39	10.03 ± 6.52	696	605	70	60
11	5	424	1.40 ± 0.27	14.24 ± 4.42	828	800	75	73
12	6	663	1.40 ± 0.29	14.12 ± 5.03	1001	1033	83	86
13	5	262	1.51 ± 0.36	22.76 ± 9.77	1165	1307	90	101
14	5	270	1.43 ± 0.32	17.85 ± 4.41	1361	1625	97	116
15	5	307	1.93 ± 0.43	33.30 ± 18.20	2034	1990	136	133
16	5	115	1.51 ± 0.28	18.72 ± 3.93	2433	2405	152	150
17	5	445	1.66 ± 0.53	27.37 ± 18.82	2802	2874	165	169
18	2	117	1.98 ± 0.23	33.66 ± 13.22	3326	3400	185	189
19	2	135	2.51 ± 0.22	48.85 ± 25.49	4687	3985	247	210

The GI couldn't only express the increase in the size of the oocytes, but also the number of other biological phenomena, which are directly related to the sexual maturity (Cayré and Laloë, 1986). Schaefer and Orange (1956) and Cayré and Laloë (1986) noted that there is a linear relationship between the GI and the diameter of the most advanced group of oocytes when this diameter is $< 300\ \mu$, while Yoshida (1966), Cayré and Farrugio (1983) and Matsumoto et al. (1984) have also pointed out that there is no evident relationship between the GI and the diameter of most advanced group of oocytes ($> 300\ \mu$). In the present study, variation between the GI and the ova diameters at the same lengths show a linear relationship ($R^2 = 0.97$) with a slop closely related to zero (0.0032). The results show a linear relationship with all ova diameter of the ripe females ready for ovulation. These results were in agreement with those of Schaefer and Orange (1956) and Cayré and Laloë (1986).

As in general, the egg size tends to be larger in a population as a result of decreased fecundity. In a Natural West African Lake the diameter of ripe oocytes was 2.04 ± 0.32 mm (Inyang and Ezenwaji, 2004) and that result was in agreement with that of the present study whereas the diameters of ripe oocytes were from 1.9 mm to 3.0 mm.

Fecundity

The absolute fecundity of *C. auratus* (10.0–19.0 cm SL) ranged from 696 to 4687 eggs. The relative fecundity ranged from 70 to 247 eggs/unit fish length (Table 6).

The relationships were curvilinear. The regression equations were as:

$$\mathrm{Log\ F_{Abs.}} = -0.1560 + 2.9376\ \ \mathrm{Log\ L}(\mathrm{R}^2 = 0.9743),\ \text{and}$$

$$\mathrm{Log\ F_{Rel.}} = -0.1560 + 1.9376\ \ \mathrm{Log\ L}(\mathrm{R}^2 = 0.9428)$$

The "b" value (2.9376) of the length – the absolute fecundity relationship exhibits insignificantly different from 3 indicating that the fish size – egg size doesn't change significantly and this result was in agreement with the one described for ova diameter (my suggestion) that shows insignificant correlation between ova diameters and standard length.

On the other hand, the analysis of the absolute fecundity and the gutted body weight revealed a linear relationship and the equation was $\mathrm{F} = 118.23 + 22.324\ \mathrm{W}$ ($\mathrm{R}^2 = 0.9760$) since the exponent "b" (0.8306) of the weight fecundity relationship is insignificantly different from 1 showing that fecundity relate linearly weight. There is no relation exists between the relative fecundity and the gutted body weight (Table 7) with a mean of 23.75 ± 1.66.

According to minimal knowledge, many authors (Table 3) described the absolute fecundity in relation to length and Laleye and Philippart (1993) showed the only study with relative fecundity in Lake Nokoue and Porto-Novo Lagoon in South Benin, Nigeria where the relative fecundity of the fresh body weight is 17.658 ± 7.017.

The results clearly evidence that *C. auratus* have different life history strategies in water of the River Nile than any other African Rivers whereas the variation in stock developmental biology in response to changing environmental condition may show adaptations of stocks to their spawning environments.

Table 7 Relation between fecundity and gutted weight of *Chrysichthys auratus* from Damietta branch of the River Nile, Egypt (January 2010–December 2010).

Weight Range	Mean weight (gm)	No. of fish	Absolute fecundity		Relative fecundity	
			Obs.	Cal.	Obs.	Cal.
25-	35	18	865	891	25	
50-	58	9	1281	1409	22	No
75-	89	6	2304	2112	26	Relation
100-	105	5	2402	2471	23	
125-	134	3	3334	3116	25	
150-	165	4	3603	3791	22	

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